

Supplement

Table S1: Correlation coefficients (CC) between catchment properties and model parameters.

CC	β	F_C	K_0	K_1	K_2	L_P	M_{MAXBAS}	P_{MAX}	V_{UZZ}
(a) Correlation coefficient on the normal scale									
Drainage area	-0.01	0.3	-0.38	0.23	0.09	-0.02	-0.24	0.03	-0.21
Drainage density	0.31	-0.4	0.16	-0.08	0.16	0.33	0.08	-0.23	0.58
Slope	-0.48	-0.02	-0.33	-0.67	-0.67	-0.15	-0.25	-0.48	0.28
Elevation	0.62	-0.53	-0.22	0.4	0.34	0.43	-0.33	-0.17	0.21
Catchment index	-0.09	-0.27	-0.29	-0.24	-0.41	0.04	-0.37	-0.35	0.25
Permeability	-0.31	0.18	-0.44	0.1	-0.04	0.02	-0.34	-0.34	-0.02
Porosity	0.21	-0.14	0.36	-0.15	-0.12	-0.07	0.35	0.4	0.06
P/PE (Wi)	-0.45	0.3	-0.23	-0.59	-0.36	-0.2	0.07	-0.34	0.26
Annual RF	-0.49	0.33	-0.07	-0.59	-0.38	-0.26	0.17	-0.26	0.16
(b) Rank correlation coefficient									
Drainage area	-0.16	0.31	-0.04	0.16	0.06	0.02	0.11	0.22	0.15
Drainage density	0.2	-0.24	0.14	0	0.05	0.1	-0.01	-0.2	-0.05
Slope	-0.53	0.09	-0.25	-0.75	-0.62	-0.24	-0.16	-0.36	0.15
Elevation	0.58	-0.57	-0.27	0.31	0.27	0.36	-0.38	-0.3	0.03
Catchment index	0.01	-0.4	-0.19	-0.09	-0.01	0.09	-0.33	-0.21	0.21
Permeability	-0.06	-0.05	-0.22	0.19	0.13	0.17	-0.29	0.07	0.25
Porosity	-0.05	-0.02	0.19	-0.31	-0.33	-0.3	0.27	0.05	-0.2
P/PE (Wi)	-0.5	0.37	-0.25	-0.74	-0.36	-0.1	0.09	-0.35	0.35
Annual RF	-0.51	0.35	-0.23	-0.76	-0.36	-0.23	0.11	-0.3	0.21
(c) Log transformed correlation coefficient									
Drainage area	-0.12	0.4	-0.24	0.17	0.17	0.1	-0.01	0.13	-0.3
Drainage density	0.22	-0.33	0.3	0.07	-0.01	0.13	0.09	-0.07	0.39
Slope	-0.5	-0.12	-0.35	-0.82	-0.63	-0.16	-0.16	-0.49	0.35
Elevation	0.65	-0.39	0	0.46	0.14	0.35	-0.3	-0.02	0.01
Catchment index	0	-0.34	-0.2	-0.17	-0.43	0.01	-0.35	-0.25	0.27
Permeability	0.38	-0.25	0.5	0.19	0.02	-0.1	0.34	0.41	0
Porosity	0.34	-0.2	0.46	0.23	-0.12	-0.08	0.31	0.49	-0.04
P/PE (Wi)	-0.49	0.15	-0.42	-0.74	-0.3	-0.27	0.1	-0.39	0.35
Annual RF	-0.52	0.17	-0.3	-0.71	-0.35	-0.31	0.16	-0.3	0.27

For permeability the Log transformation results in the complex numbers, thus the absolute values of the variables were taken for the correlation analysis.

Table S2: Catchment properties that are derived for streamflow prediction in the ungauged catchments using the 14 parameter sets obtained by the weighted regression.

Ungauged cats no	Area [km ²]	DD [km/km ²]	Mean slope [%]	Mean Elev[m]	Cat Index [m/km]	Permeability [log ₁₀ m ²]	Porosity [-]	Wi [-]	P [mm]	PET [mm]
ung1	5324.1	0.075	16.22	2037.1	10.07	-12.194	0.07	0.85	923.6	1086.6
ung2	591.54	0.21	13.99	719.63	10.12	-10.73	0.060	0.86	842.6	983.6
ung3	181.16	0.50	13.49	1772.80	17.27	-12.07	0.022	1.06	1140.1	1075.4
ung4	130.86	0.30	21.13	1795.40	10.92	-12.34	0.087	1.04	1140.1	1093.3
ung5	151.33	0.56	21.55	1557.70	43.55	-11.51	0.048	0.85	928.9	1093.0
ung6	185.10	0.44	29.60	2237.90	57.08	-11.58	0.106	1.03	1265.5	1224.2
ung7	1791.10	0.12	25.73	1236.80	10.41	-11.59	0.034	0.58	655.6	1134.3
ung8	233.45	0.32	33.53	1825.10	59.34	-11.93	0.072	0.94	1076.2	1146.3
ung9	203.97	0.45	25.55	1102.40	28.68	-11.05	0.043	0.61	631.7	1033.9
ung10	521.98	0.31	11.19	679.33	9.44	-10.94	0.023	0.63	660.6	1043.9
ung11	143.19	0.49	11.24	1697.10	6.19	-11.76	0.005	0.69	798.0	1152.5
ung12	62.66	0.96	13.24	1787.20	27.16	-12.34	0.036	0.68	848.4	1242.5
ung13	78.96	0.81	16.72	2252.30	41.57	-12.50	0.090	0.70	848.4	1206.2
ung14	140.85	0.48	16.67	2158.70	17.93	-11.93	0.080	0.87	995.7	1143.6
ung15	603.71	0.43	14.32	2159.30	19.29	-12.50	0.090	0.92	995.7	1084.8
ung16	929.61	0.27	12.80	1802.70	8.74	-12.37	0.092	0.94	1028.8	1089.0
ung17	217.98	0.55	17.15	2536.30	37.29	-12.12	0.085	0.95	995.7	1048.5
ung18	189.71	0.50	19.23	2540.10	34.28	-12.12	0.082	0.71	848.4	1190.7
ung19	189.09	0.43	18.80	2406.10	38.12	-12.12	0.079	0.71	848.4	1191.1
ung21	241.08	0.34	25.61	1586.00	29.87	-11.73	0.056	0.98	1076.2	1100.5
ung22	240.43	0.36	17.58	1310.20	16.17	-11.97	0.107	0.88	928.9	1050.4
ung23	214.66	0.41	26.15	1686.70	32.88	-11.58	0.003	1.05	1265.5	1208.8
ung24	762.79	0.19	12.70	875.24	16.74	-11.44	0.033	0.88	842.6	959.3
ung25	676.87	0.25	10.64	975.03	17.64	-11.73	0.069	0.84	842.6	1007.2
ung26	1307.80	0.17	7.93	1159.50	9.23	-11.38	0.064	0.50	545.6	1095.5
ung27	434.37	0.25	29.84	1476.90	36.78	-11.88	0.099	0.60	631.7	1053.1
ung28	749.14	0.21	18.97	1294.40	15.55	-11.56	0.050	0.60	631.7	1049.7
ung29	892.62	0.21	15.98	995.88	7.23	-11.75	0.094	0.48	502.2	1038.4
ung30	1164.90	0.18	21.67	1536.20	15.96	-11.05	0.089	0.47	502.2	1073.5
ung33	153.06	0.76	15.67	2534.00	42.81	-12.5	0.048	0.74	848.4	1139.8
ung34	231.39	0.54	9.08	1643.20	7.37	-12.24	0.060	0.66	798.0	1213.1
ung35	290.84	0.41	9.50	1801.10	9.48	-11.21	0.022	0.77	890.3	1154.0
ung36	3424.40	0.17	20.18	1592.30	10.13	-11.75	0.087	0.80	896.1	1122.7

DD-Drainage density, Wi – Wetness index, P - Annual average precipitation, PET – Potential evapotranspiration

Table S3: The maximum NSE and standard deviations (std) on the daily scale during calibration and validation, and the corresponding monthly performance for the best parameters derived from calibration, validation, and stable sets.

Catchment No	Gauge location	NSE daily (Cal)	NSE daily (Val)	NSE monthly (Cal)	NSE monthly (Val)	NSE monthly (stable parameters)	std of daily NSE (Cal)	std of daily NSE (Val)
#01	Bilate@Tena	0.63	0.58	0.81	0.78	0.74	0.0317	0.0231
#02	Gelana@Tore bridge	0.63	0.67	0.72	0.74	0.69	0.0343	0.0483
#03	Gidabo@Measso	0.69	0.66	0.77	0.73	0.70	0.0456	0.0462
#04	Gedemso@Langanano	0.65	0.58	0.77	0.70	0.69	0.0354	0.0195
#05	Woito@bridge	0.55	0.49	0.63	0.62	0.61	0.012	0.0213
#06	Djidu@Hitsanat amba	0.13	0.15	0.45	0.55	0.21	0.0275	0.0276
#07	Hamassa@Wajifo	0.18	0.36	0.58	0.66	0.46	0.0458	0.0841
#08	Hare	0.5	0.38	0.70	0.48	0.48	0.0021	0.0443
#09	Katar@Abura	0.66	0.77	0.795	0.86	0.73	0.0411	0.06
#10	Kulfo@Arbaminch	0.4	0.27	0.77	0.49	0.36	0.0448	0.0614
#11	Meki@Meki village	0.7	0.84	0.84	0.95	0.74	0.0517	0.0854
#12	Tikur wuha@Bridge	-0.54	-0.14	-0.17	-0.01	-0.37	0.9031	0.7355
#13	Gidabo@Bedesa*	0.51	0.64	0.67	0.82	0.41	0.0021	0.0054
#14	Katar@Fete*	0.56	0.62	0.74	0.77	0.71	0.0166	0.1544
#15	Katar@Timela*	0.38	0.6	0.78	0.8	0.79	0.002	0.0023
#16	Gidabo@Aposto*	0.6	0.77	0.76	0.87	0.79	0.0239	0.1261

*are nested catchments within another gauged catchment

Table S4: Monthly NSE values obtained during calibration, validation, and stable parameter sets, and the corresponding NSE values derived from the three-parameter sets from the regression model during the validation period.

Gauge location	NSE _{cal}	NSE _{val}	NSE _{stable}	NSE REG _{cal}	NSE REG _{val}	NSE REG _{stable}
#01	0.81	0.78	0.74	0.47	0.37	0.092
#02	0.72	0.74	0.69	0.13	-0.42	-0.33
#03	0.77	0.73	0.70	0.47	0.48	0.4
#04	0.77	0.7	0.69	0.68	0.67	0.68
#05	0.63	0.62	0.61	0.40	0.64	0.63
#07	0.58	0.66	0.46	0.49	0.34	0.44
#08	0.70	0.48	0.48	-9.6	-2.22	-6.65
#09	0.795	0.86	0.73	0.82	0.81	0.82
#10	0.77	0.49	0.36	-0.22	-0.49	-0.03
#11	0.84	0.95	0.74	0.31	0.31	0.35
#13	0.67	0.82	0.41	0.68	0.64	0.69
#14	0.74	0.77	0.71	0.83	0.75	0.81
#15	0.78	0.8	0.79	0.66	0.66	0.64
#16	0.76	0.87	0.79	0.71	0.69	0.63